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Original Article

Importance of Disinfection Time and Procedure with Different Alginate Impression Products to Reduce Dimensional Instability

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Abstract

Aims: The aim of this study was to determine the best approach to reduce the unfavorable change in the three different dimensions of impressions using disinfection durations of 15 and 30 min; three different disinfection procedures; and alginate impression products as research factors. **Materials and Methods:** CA37, impressional, and cream alginate impressions were used; distortion in the AB, AC, and BC dimensions of impressions using disinfection durations of 15 and 30 min was studied; and no disinfection (ND), conventional disinfection (CD), and sonicator-activated disinfection (SAD) procedures were measured. **Results:** Regarding AB dimension, the impressional has best performance when CD was applied for both 15 and 30 min. When SAD was applied for 15 min, impressional and cream alginates provide best performance. When CD was applied for 15 min, CA37 and impressional alginates provide best performance. Although ND-applied CA37 alginate after 30 min provides best performance, because of many outlier values, its implication may not be considered as meaningful. Regarding AC dimension, cream alginate has best performance when CD was applied for 15 min. The AC distances in all the alginates are considerably different from the base model after 30 min. Regarding BC dimension, only the CA37 alginate has the best performance when ND was applied for 15 min. All the alginates are considerably different from that of the base model after 30 min. **Conclusion:** Preference of 15-min disinfection can provide favorable results to obtain all impressions with minimally distorted dimensions. CD is an adequate procedure. The studied SAD needs to be developed further. All alginates are comparably successful to obtain impressions with desired distortion degrees.

Keywords: *Dental disinfectants, dental impression, dimensional stability, prosthodontics, ultrasonic homogenizer*

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Introduction

Dental impressions are creating negative shape of oral structures that are useful for working on die materials obtained from dental models.[1] Every year, new technologies and materials are introduced to dental professionals, although conventional materials and techniques are still preferred in clinics and laboratories. There is a continuing need of knowledge about the properties and usage of new approaches and how to capture exact form of oral tissues with precise material and effective technique to provide appropriate dental treatment process.

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Dental impressions may cause contamination of various microorganisms to dental professionals. Dental clinicians need to concern regarding infection control, and all surfaces of impressions need to be disinfected with a hospital-grade disinfectant.[2] Despite studies in literature, there is a need for consensus development on the ideal composition and concentration of chemical disinfectant, optimal exposure time, and

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the interaction between impression materials and disinfectant solutions.[3,4] During their application to the oral cavity, dental impressions are generally exposed to human blood and saliva;[5] and therefore, due to the risk of cross-contamination in the dental clinics and laboratories, professionals should follow coordinated disinfection protocols.[6,7] The disinfection process should start immediately from the mouth to increase effectiveness.[7] There are many studies in the literature to investigate the influence of disinfection process on the surface properties and dimensional stability of dental impression materials.[8-12] Immersion of the impressions is a more effective technique than disinfection with spray.[13-16] However, immersion technique can cause dimensional changes in the impressions which can decrease the quality of prosthetic results achieved in dental practices.[17]

In dental practice, the most commonly used impression material is alginate which is an elastic-irreversible hydrocolloid material.[8] This material is generally used for the production of immediate/interim complete or partial denture prostheses because of many advantages, particularly hydrophilicity properties.[18] Some advantages of this materials are good wetting properties, low technique sensitivity, hydrophilicity, ease of manipulation, compatibility with cast material, pleasant taste and odor, low cost, long shelf-life, and better choice to fabricate diagnostic casts.[1,19] In addition, in clinic practice, dentists prefer alginate; for wet surface (saliva and blood), the hydrophilic properties of the impressions are important advantage for the recording of details; in the presence of undercuts in oral environment, dentists can easily remove the alginate impression from the mouth due to flexible properties; it has adequate setting time to be handled and placed in the oral cavity with easy to use and easy to mix properties.[20] However, alginate impression materials have low-dimensional stability due to their imbibition and syneresis properties and this condition causes distortion and shrinkage.[20,21]

A considerable amount of literature has been published on different disinfection products, procedures, contact times, and disinfectant agents. However, an universally recognized disinfection is still lacking. The influence of disinfection on the impression materials is mainly not considered in dental clinics and laboratories. Since none of the available impression materials was originally formulated for disinfection, it is logical that disinfectant solutions may adversely affect the dimension of stability of impressions and production of final gypsum model. We thought that a study including different immersion durations and disinfection techniques applied on different commercial alginates may shed light on the effect of disinfection on the dimensional stability of impressions. The aim of this study was to determine the best approach to minimize distortion in the AB, AC, and BC dimensions of impressions in a laboratory setting using disinfection durations of 15 and 30 min; no disinfection (ND), conventional disinfection (CD), and sonicator-activated disinfection (SAD) procedures; and alginate impression products as research factors.

Materials and Methods

A total of 144 impressions were prepared for this study. For each alginate impression material [Table 1], 48 impressions were made and divided into three different disinfection protocols as follows (n = 16): ND, CD, and SAD. Each disinfection group was divided into two different subgroups according to storing time (n = 8): 15 and 30 mins. Impression materials and gypsum products were portioned, mixed, and manipulated according to the manufacturer's instructions by one operator. Distilled water at room temperature was used for all mixes of gypsum and impression material.

Table 1: Properties of alginate products given by the manufacturer

Alginate product	Powder/water ratio	Composition	Detail production
Cavex CA37	21.2/46	*Alginate*: app. 14% w *Calcium sulfate*: app. 10% w *Fillers*: app. 70% w *Retarder, stabilizers, pigment, and flavor*: app. 6% w	50 µm
Cavex Impressional	19.3/46	*Alginate*: app. 15% w *Calcium sulfate*: app. 10% w *Fillers*: app. 69% w *Retarder, stabilizers, pigment, and flavor*: app. 6% w	25 µm
Cavex Cream	21.2/46	*Alginate*: app. 14% w *Calcium sulfate*: app. 10% w *Fillers*: app. 70% w *Retarder, stabilizers, pigment, and flavor*: app. 6% w	5 µm

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Dimensional stability

The dimensional stability of the impressions was evaluated indirectly by measuring three different dimensions on gypsum casts recovered from impressions of an acrylic maxillary edentulous base model. Post screws were used for reference marks (A–C) for making measurements on the base model positioned on midline and both tuber regions. Before preparing special tray, a light coat of petroleum jelly was placed on the base model and uniformly covered with 2-mm thickness of wax with "stops" cut out in the approximate positions of the palatine fovea and left and right premolar positions. A custom-made light-cured acrylic special tray (LC Trays, Kemdent, UK) was prepared for taking impression with accurate positioning of the tray and allowed a uniform thickness of impression material.

Impression materials were portioned, mixed, and manipulated according to the manufacturer's instructions by one operator. Distilled water at room temperature was used for mixing impression materials. Impressions were prepared with hand-mixing to a homogeneous consistency for 30 s and were taken of the base model applying gentle pressure and allowed to set for 1.5 min after which they were removed from the base model in a single rapid movement. All impressions were rinsed for approximately 10 s under cold tap water to simulate saliva and any residue removal.

Disinfection procedure

ND group samples were stored by covering with wet gauze to keep the surface moist as in general practice. CD group samples were immersed in a quaternary ammonium-based disinfectant (Zeta 7 Solution, Zhermack SpA, Italy) at room temperature. In the SAD group, an ultrasonic homogenizer (Bandelin-2070, Bandelin Electronic, Germany) was used for activating the disinfectant solution at 20 kHz [Figure 1]. In all procedures, two different storing times were applied for both 15 and 30 mins.

After disinfection procedures, all groups were rinsed again for 10 s under cold tap water and dried with air. All impressions were cast using type IV die stone gypsum (Denston, Ata Industry and Trade Inc., Turkey) with a ratio of 22 mL/100 g. The gypsum products were hand spatulated for 1.5 min and poured into the impression using vibration and allowed to set for 1 h at room temperature. After setting of the gypsum, the casts were removed from the impression and prepared for measurement.

The measurements were recorded by one operator with a digimatic caliper (ABS, Mitutoyo Co., Japan) capable of measuring up to 0.01 mm being used to measure

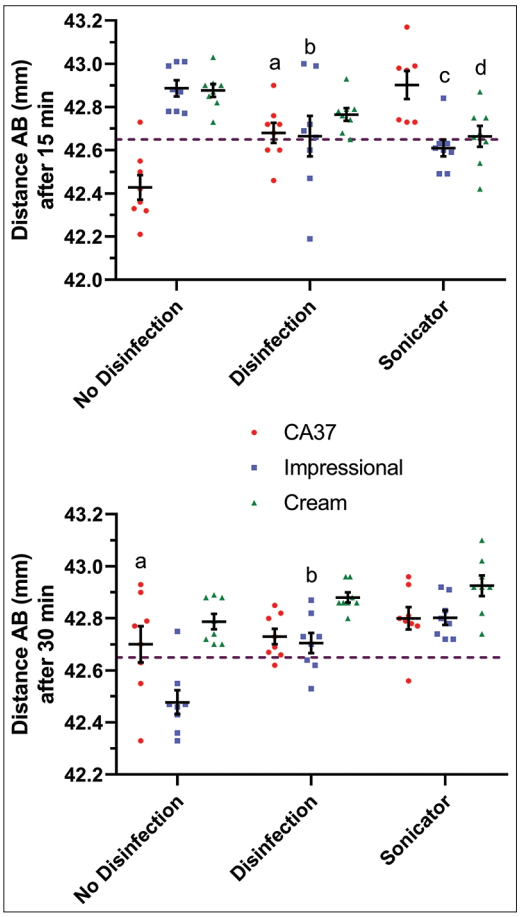


Figure 1: AB distance of impressions of CA37, impressional, and cream alginates after application of no disinfection, conventional disinfection, and sonicator-activated disinfection procedures for 15 and 30 mins. Data are expressed mean ± SEM ($n = 8$ for every subset). Dashed line shows the AB distance of the base model. Because the objective of this study is to determine the optimal alginate, disinfection, and time option that provide minimal distortion and no significant difference in the studied impression from the AB distance of the base model, no significant differences with letters are presented as the follows: $^{a, b, c, d, e, f}P > 0.05$ vs. the mean distance AB of the base model. Overall, the impressional alginate has best performance when conventional disinfection was applied for both 15 and 30 min. When sonicator-activated disinfection was applied for 15 min, impressional and cream alginates provide best performance. When conventional disinfection was applied for 15 min, CA37 and impressional alginates provide best performance. Although no disinfection-applied CA37 alginate after 30 min provides best performance, because of many outlier values, its implication may not be considered as meaningful

three clinically important features of the gypsum casts including AB, AC, and BC lengths. The measurements were taken three times of each linear measurement and the mean of the three values was taken for this study. The measurements were compared with those recorded from the base model.

Statistical analysis

Data were analyzed using *t*-test to compare the measured dimensions of gypsum casts after study procedures with those measured of the base model. Data were expressed as mean ± standard error of mean. A *P* value of less than 0.05 was accepted as significant.

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Results

In the study, during the comparisons of AB distances, we used AB, AC, and BC distances of the base model as standard. Because the objective of this study is to determine the optimal alginate, disinfection, and time option that provide minimal distortion and no significant difference in the distances AB, AC, and BC of the studied impressions from the distances AB, AC, and BC, respectively, of the base model, no significant differences obtained after statistical analyses with *t*-test were mentioned as meaningful.

Figure 2 presents the AB distance of impressions of CA37, impressional, and cream alginates after application of ND, CD, and SAD procedures for 15 and 30 mins. Overall, the impressional alginate had no significantly different AB distance compared with that of the base model when CD was applied for both 15 and 30 min ($P > 0.05$). When SAD was applied for 15 min, impressional and cream alginates had no significantly different AB distances compared with that of the base model ($P > 0.05$). When CD was applied for 15 min, CA37 and impressional alginates had no significantly different AB distance compared with that of the base model ($P > 0.05$). Although ND-applied CA37 alginate after 30 min had no significantly different AB distance compared with that of the base model ($P > 0.05$), because of many outlier values, its implication may not be considered as meaningful.

Figure 3 shows the AC distance of impressions of CA37, impressional, and cream alginates after application of ND, CD, and SAD procedures for 15 and 30 min. Overall, cream alginate had no significantly different AC

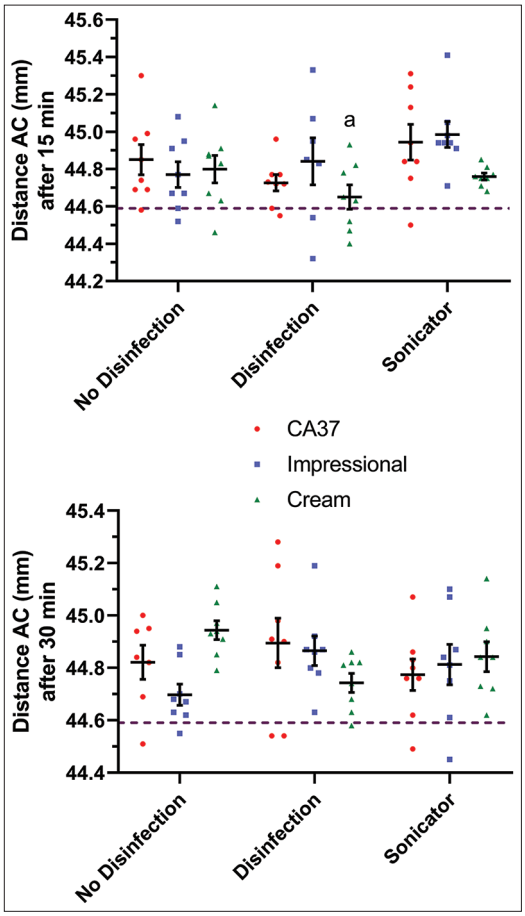


Figure 2: AC distance of impressions of CA37, impressional, and cream alginates after application of no disinfection, conventional disinfection, and sonicator-activated disinfection procedures for 15 and 30 min. Data are expressed mean ± SEM ($n = 8$ for every subset). Dashed line shows the AC distance of the base model. Because the objective of study is to determine the optimal alginate, disinfection, and time option that provide minimal distortion and no significant difference in the studied impression from the AC distance of the base model, no significant differences with letters are presented as the follows: $^{a}P > 0.05$ vs. the mean AC distance of the base model. Overall, cream alginate has best performance when conventional disinfection was applied for both 15 and 30 min. The AC distances in all the alginates are considerably different from that of the base model after 30 min

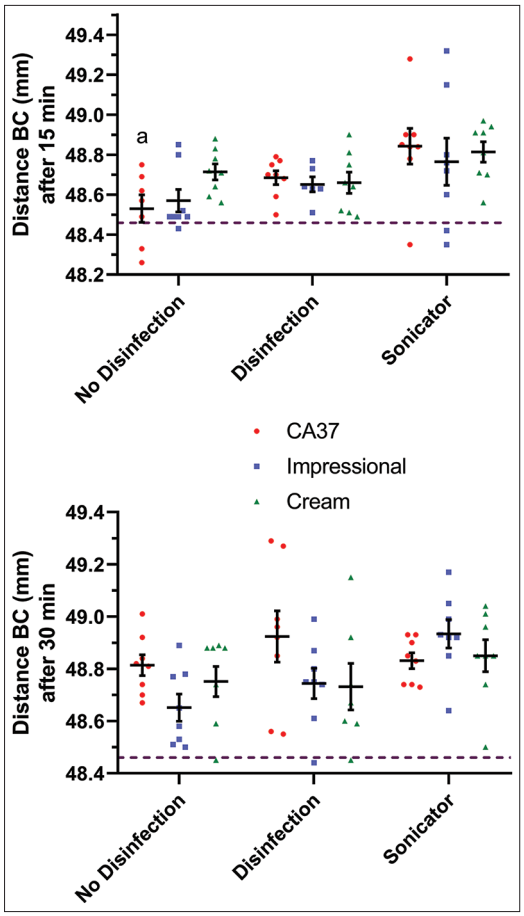


Figure 3: BC distance of impressions of CA37, impressional, and cream alginates after application of no disinfection, conventional disinfection, and sonicator-activated disinfection procedures for 15 and 30 min. Data are expressed mean ± SEM ($n = 8$ for every subset). Dashed line shows the BC distance of the base model. Because the objective of study is to determine the optimal alginate, disinfection, and time option that provide minimal distortion and no significant difference in the studied impression from the distance BC of the base model, no significant differences with letters are presented as follows: $^{a}P > 0.05$ vs. the mean distance BC of the base model. Overall, only CA37 alginate has best performance when no disinfection was applied for 15 min. The BC distances in all the alginates are considerably different from that of the base model after 30 min

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Figure 4: A picture of ultrasonic homogenizer used for disinfection

distance compared with that of the base model when CD was applied for 15 min ($P > 0.05$). The AC distances in all the alginates are significantly different from that of the base model after 30 min ($P < 0.05$).

Figure 4 displays the BC distance of impressions of CA37, impressional, and cream alginates after application of ND, CD, and SAD procedures for 15 and 30 min. Overall, CA37 alginate had no significantly different BC distance compared with that of the base model when ND was applied for 15 min ($P > 0.05$). The AC distances in all the alginates are significantly different from that of the base model after 30 min ($P < 0.05$).

Discussion

This is the first study comparing the unfavorable change in the AB, AC, and BC dimensions of impressions in a laboratory setting using disinfection durations of 15 and 30 min; ND, CD, and SAD procedures; and CA37, impressional, and cream alginate types as research factors. The results of this study provided important implications. Overall, application of disinfection procedures for 15 min can be accepted suitable to cause minimal distortion in all the distances of impression; usage of sonicator during disinfection did not provide favorable effect to reduce distortion of dimensions of impressions; and considering distortion level of all the measured dimensions, all the studied CA37, impressional, and cream alginate types can be accepted as comparably successful to produce impressions.

Shaba *et al*.[22] conducted a study to determine the dimensional stability of alginate impressions poured at varying time intervals of 5 min, 30 min, 1 h, 2 h, and 4 h in a tropical environment. They noted that there was no meaningful difference in dimension of the cast at 10 min but not at all the other time periods. They suggested that alginate impressions should be cast within 10 min for not more than 30 min will be clinically usable. Kulkarni *et al*.[23] evaluated the effect of variations in time of pour and temperature on dimensional stability of three brands of commercially available alginates. They demonstrated that impressions showed least distortion at varying degrees of temperature for 20 min. Wadhwa *et al*.[24] investigated the time-dependent (0, 12, 30, and 60 min) accuracy of casts made from three different irreversible hydrocolloids. The results showed that no statistically significant differences in the accuracy of casts were obtained at different time intervals. They noted that all irreversible hydrocolloid materials studied could be stored in a zip-lock plastic bag for up to 1 h without any significant distortion. Taken together, the time factor needs to be considered during preparation of alginate impressions. According to findings of this study, the duration of 15 min can be chosen for disinfection to minimize alteration of alginate dimensions.

A number of disinfectant solutions are preferred for using in dental filed including sodium hypochlorite,[25-28] sodium metabisulphite,[28,29] and glutaraldehyde.[30-32] The results of those studies have varied greatly depending of the techniques and material evaluated. Dental impression materials which are the commercially available, not applicable for disinfection. Disinfection procedures may have an adverse effect for the dental impressions. Kang *et al*.[33] compared the water contact angles of a polyvinyl siloxane impression material treated with either a quaternary ammonium-based or a chlorine-based disinfectant for various exposure times. They noted that the quaternary ammonium-based disinfectant is more effective in removing the surfactant than a chlorine-based disinfectant. Vlahova *et al*.[34] presented a new method they developed for photodynamic disinfection of prostheses and impressions in prosthetic dentistry and to assess its effectiveness in comparison to some conventional methods (quaternary ammonium-based) of disinfection. The authors recommend that Zeta 7 Spray is 100% effective method of disinfection of impression materials with respect to *Pseudomonas aeruginosa*. They believe that Zeta7 Spray is the most reliable method of disinfection of impression materials of all tested methods. In a review[35] of dimensional stability of irreversible hydrocolloid impression materials as a function of pouring time and disinfectant solutions used, the authors suggested that while traditional irreversible hydrocolloid impressions are most stable when disinfected and poured immediately, this is not the case for extended-pour materials. They noted that selecting a disinfectant and disinfecting method may be important for the stability of irreversible hydrocolloids. A significantly high level of microbial adherence to the surface of alginate impressions can be noted.[36]

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As limitations of this study, an ultrasonic sonicator optimized for the disinfection of impressions was not used. We think that use of ultrasonic sonicator during disinfection might be helpful for continuous mixing of disinfection solution and obtaining more effectively disinfected impressions. In addition, the time factor might be chosen as 15, 20, 25, and 30 min intervals. This can ease the understanding of time factor for optimizing disinfection duration.

Clinicians need to be aware of the setting characteristics of each of the alginate impression material available currently in the market to choose appropriate one for each clinical situation. There is continuing improvement of their properties including pour time and dimensional stability. Although the elasticity of modern alginates is generally good during their use in clinical settings, there are some differences among them regarding dimensional accuracy, syneresis, imbibition, and detail reproduction.[23]

In conclusion, the results of this study have clinical implications. The preference of 15-min disinfection can provide favorable results to obtain impressions with minimally distorted dimensions. During the preparation of impressions, disinfection is an important step and CD is an adequate procedure. The studied SAD needs to be developed further before use in dental laboratories. The studied alginate types of CA37, impressional, and cream are comparably successful to obtain impressions with desired distortion degrees. Therefore, clinicians and dental laboratory technicians should follow strict rules to disinfect alginate impressions by chemical disinfectants to avoid unwanted dimension alterations.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Ethical approval and consent to participate

The present in vitro study does not include any patient data and patient contribution. So not Ethics Committee approval nor consent to participate was requested.

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